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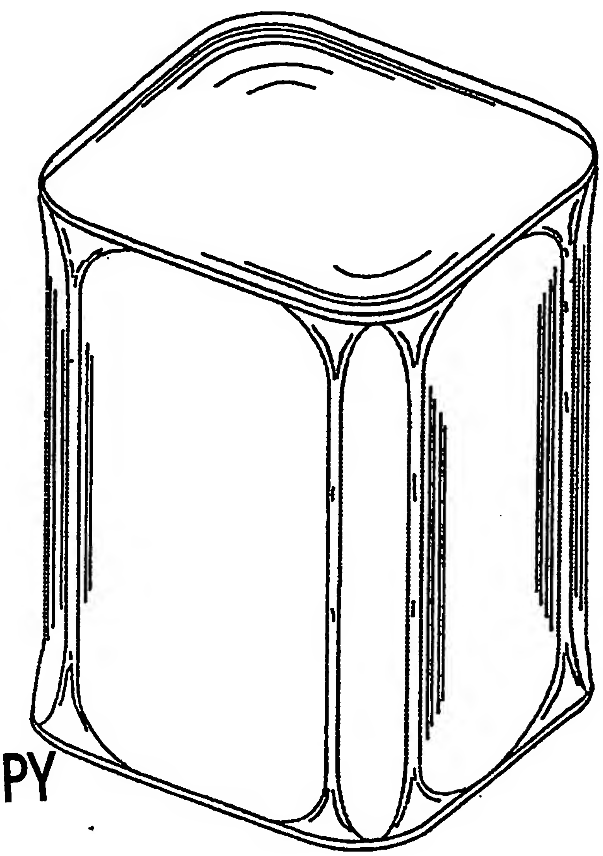
(57) Abstract

Metal body for packaging purposes comprising a closed metal shell extending around a longitudinal axis which is suitable for being provided on a side named here as the top with a lid running essentially perpendicular to the longitudinal axis, whereby the cross section through the shell on and closed to the top has a contour comprising $3 \leq n \leq 6$ curved concavely inwards with a minimum radius of curvature R, and n essentially straight contour line pieces, as well as in that the shell comprises at least n essentially flat shell parts, which are separated from one another by a sharp fold running essentially parallel to the longitudinal axis, which fold has a maximum radius of curvature r, whereby $r \leq 0.4$ R.



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METAL BODY FOR PACKAGING PURPOSES, FOR EXAMPLE A FOOD CAN

The invention relates to a metal body for packaging purposes comprising a closed metal shell extending around a longitudinal axis which is suitable for being provided on a side named here as the top with a lid running essentially perpendicular to the longitudinal axis.

Such a body is known for example as a component of a packaging container, for example a food can.

Besides its body, a three-piece packaging container comprises a base and a lid. With a two-piece packaging container the body and base are in one piece. In general the conventional packaging container is circular cylindrical, possibly provided with beads running essentially parallel to the lid face, or 'blown up' in a somewhat bulging shape.

Also known is a packaging container of an essentially circular cylindrical shape which has finger-shaped panels curved convexly inwards and extending up the height of the wall.

The object of the invention is to create a lightweight packaging container, which, while also breaking away from the conventional circular cylindrical shaped appearance and improving the stiffness, achieves advantages discussed below in more detail.

To this end the body in accordance with the invention is characterised in that the cross-section through the shell on and close to the top has a contour comprising

$3 \leq n \leq 6$ curved concavely inwards with a minimum radius of curvature R, and n essentially straight contour line pieces, as well as in that the shell comprises at least n essentially flat shell parts, which end at least on one side in a sharp fold running essentially parallel to the longitudinal axis, which fold has a maximum radius of curvature r, whereby $r \leq 0.4$ R. In this context an essentially flat shell part shall be held to comprise a shell part that is slightly convex or slightly concave or that comprises one or more inwardly and/or outwardly protruding terraces.

Here it is preferable that $R \geq 15$ mm and $r \leq 5$ mm.

In a particular embodiment the flat shell parts run essentially parallel to the straight contour line pieces.

The body has for example 2n essentially flat shell parts and preferably 2n sharp folds. The body then appears as illustrated in Fig. 1.

The invention is also embodied in a method for heat treating, for example sterilising a filled can comprising a body in accordance with the invention, whereby a pressure p_{amb} is exerted on the can and a pressure p_{can} prevails in the can, whereby $\Delta p = p_{can} - p_{amb}$, and $p_1 < \Delta p < p_2$, characterised in that $p_1 \lll p_{1\ ref..}$ and $p_2 \leq p_{2\ ref..}$, where $p_{1\ ref..}$ and $p_{2\ ref..}$ represent respectively the minimum and maximum Δp for a conventional reference can.

It is found that when the can in filled state with a body in accordance with the invention is heat treated in an autoclave, it needs to be handled far less critically

in terms of pressure. The external pressure on the can may be set far higher and does not need to be reduced accurately on cooling.

The invention is also embodied in a gas-tight can filled with non carbonated drink or food, such as vegetables, fruit, pet food, fish, meat or soup, comprising a metal body in accordance with the invention, preferably a can of packaging steel, whereby the material thickness of the packaging steel of which the body is made is thinner than 0.16 mm. It is even possible to use sterilisable cans in accordance with the invention which are manufactured with a thickness of less than 0.15 mm, 0.14 mm, 0.13 mm or even less than 0.12 mm.

The invention will now be illustrated by reference to the drawing, in which

Fig. 1 shows a square tall can in accordance with the invention;

Fig. 2 shows a square short can in accordance with the invention;

Fig. 3 shows a cross-section of a can in accordance with the invention at and close to the top and at a slight distance from it;

Fig. 4 shows the deformation of the (filled) can in accordance with the invention as a consequence of the external pressure at different stages of can filling;

Fig. 5 shows the flexibility of various shapes of cans including the cans in accordance with the

invention;

Fig. 6 shows the relation between the autoclave pressure and Δp as defined;

Fig. 7 shows the relation between the maximum autoclave pressure that can be borne by various shapes of filled cans and different degrees of filling of the cans.

Fig. 1 shows a can in accordance with the invention with a content and height corresponding to a circular cylindrical food can of 73 mm diameter and 110 mm height.

The can may also be designed differently, for example shorter as shown in Fig. 2.

In Fig. 3 R indicates the curvature of radius of the curved contour line pieces and the top of the shell of the can in accordance with the invention, and r is the curvature of radius which the shell has at a fold.

The can in accordance with the invention, for example as shown in Figs. 1, 2 and 3, has the advantage that for the same content it takes up less space than the conventional circular cylindrical can, something which is of great importance on shop shelves or in the distribution chain.

The can in accordance with the invention has for example a width/depth of approx. 66 mm and a height of 110 mm, while at that height the conventional can has a diameter of approx. ∅ 73 mm. Consequently for the same filled content, the can in accordance with the invention takes up some 20 % less space when being placed in rows

than the known circular cylindrical can.

Furthermore, the can in accordance with the invention has less weight in packaging material than the conventional can. For the dimensions cited the conventional can weighs around 50 grams, while the can in accordance with the invention weighs about or even less than 40 grams.

Because, with a difference Δp between the pressure in the can P_{can} and the ambient pressure P_{amb}, the (filled) can in accordance with the invention can deform more than the conventional can, the content is able to support the can even under a high external pressure (negative Δp) without the can collapsing, which in practice offers great advantages as described later. Also in case of a high internal pressure the flexibility of the can according to the invention compensates pressure differences. This has the effect that conventional sterilisation procedures suffice.

During the sterilisation process the pressure in the can changes as a consequence of the temperature changes. This change in pressure in the can must be compensated by a change in pressure in the surroundings of the can in order to stop the can bursting apart or collapsing into itself. In general during the sterilisation process this ambient pressure (autoclave pressure) is kept controlled.

If the temperature and pressure in the can is not able to follow the fall in temperature and pressure in the surroundings quickly enough, the can may permanently

deform or collapse outwards. Then the most common deformation is the lid bulging out.

A can collapsing inwards occurs when the temperature and pressure in the can have dropped, while the pressure in the autoclave is still high. The known round, usually ribbed food can then collapses inwards in 3, 4, 5 or more sides.

During the cooling process the risk of the can deforming outwards (bursting apart) changes to the can deforming inwards (collapsing inwards). This means that during cooling the pressure in the surroundings of the known can must be allowed to reduce gradually.

In practice controlling this ambient pressure proves difficult.

This is because, depending on the local conditions, position and orientation, there are differences in pressure in the cans due to differences in heating/cooling rates of the cans. At present collapsing is overcome by imposing high demands on the mechanical strength of the can. For example, the known ∅ 73 x 110 mm food can must be able to withstand a pressure difference Δp from $p_{1\ ref..}$ = -1.2 bar up to p_2 = 1.75 bar without permanently deforming. The working range for Δp extends from $p_{1\ ref..}$ to $p_{2\ ref..}$. Where $\Delta p < p_{1\ ref..}$ the known can will then collapse inwards, where $\Delta p > p_{2\ ref..}$ that can will then burst.

With the can in accordance with the invention the

relationship between the pressure difference in the can and the expansion volume is far more flexible than with a conventional reference food can. This has a number of advantages.

Firstly as long as the can is filled leaving a head space of a certain max. amount there is no risk of the can collapsing inwards. With conventional cans there is a risk of the walls of the can collapsing inwards in the case that $\Delta p > p_1$.

To prevent this the wall of the known can has its bending stiffness increased by beads being placed around the circumference and material of adequate thickness is used, for example of over 0.16 mm for a ∅ 73 x 110 mm food can. With the flexible can its potential to expand is such that the overpressure outside it can be borne by the content of the can and no longer by the side wall of the can. The can in accordance with the invention can withstand a very high external overpressure. For the can in accordance with the invention it is no longer necessary to place demands on the stiffness (thickness, beads) of the can wall to prevent the can wall from collapsing inwards. Consequently the working range of this can is a good deal greater. In practice this means that the pressure control of the autoclave is far easier to achieve. As long as the pressure in the autoclave is higher than the pressure in the can nothing can go wrong.

Fig. 4 gives the results of several experiments, whereby cans in accordance with the invention were filled

by fully topping them up with water of 80 °C on a pair of scales, and, in order to create some headroom, 2.5 %, 5 % and 10 % water was removed respectively. The cans filled in this manner to the extent of filling of 90 %, 95 % and 97.5 % were then closed and after cooling to room temperature in a pressure chamber they were tested for deformation behaviour.

Fig. 4 represents vertically the deformation of a side wall of the can, and horizontally the external pressure in bars, and at the rear the extent of filling expressed in percent. During testing an exertion of overpressure increasing in stages by 0.5 bar (0.5 ... 3 bar) was alternated with an atmospheric pressure (0 bar). It is clear to see that with a higher extent of filling of over 95 % the permanent deformation is drastically less than with a lower extent of filling.

Therefore, with the can in accordance with the invention a great part of the external loading is as it were borne by the contents, so that less demanding requirements need to be imposed on the can itself.

Because the can has this greater potential to expand, the headroom in the can may be reduced. This means that the can in accordance with the invention can contain more food, and that the risk of perishing as a consequence of oxygen inclusion is reduced.

Thirdly it is no longer necessary to place horizontal beads in the can wall, which increases the axial strength of the can. Axial strength is necessary in order to

prevent damage to a can during processing, for example when flanging and closing and during transport. This also has the advantage that the product designation, for example a label or printing can take place more easily and offers a more attractive appearance. Lastly it is now possible to use even thinner material for the can wall.

In Fig. 5, 6 and 7 various properties of different shapes of cans have been illustrated in diagrams. With dash-dotted lines, further indicated with reference numerals 1, properties of conventional cans with a diameter of approximately ∅ 73 mm and a height of 110 mm have been illustrated. The drawn lines, indicated with reference numerals 2, relate to cans of similar height but with a square cross-section with width and depth of approximately 66 mm and with rounded corners with a curvature R as shown in Fig. 3. The dotted lines, indicated with reference numerals 3, relate to cans of similar height but with a square cross-section with width and depth of approximately 66 mm and with flattened corners as shown in the lower part of Fig. 3.

Fig. 5 illustrates the flexibility of these cans. Along the horizontal axis the pressure change in bar excerted on the cans is shown and along the vertical axis the relative change in volume in %. All cans were closed but empty. Apparently the can with the flattened corners (3) combines a high flexibility with an increased implosion performance.

Fig. 6 illustrates the failure of cans under various

pressure conditions in an autoclave, indicated along the horizontal axis in absolute pressure in the autoclave in bars. All cans had been filled up to a free head space of 5 % of the can contents. Along the vertical axis the pressure difference Δp (= p_{can} + p_{amb}) over the can body has been indicated. The horizontal lines with reference numerals 1a, 2a and 3a illustrate the strength of the circular-cylindrical cans, the square cans with rounded corners and the square cans with flattened corners per se. The known ∅ 73 x 110 mm can 1 shows a nearly linear relation of Δp with the absolute autoclave pressure. At the intersection x of lines 1 and 1a the can will fail and will implode. Similarly at the intersections of lines 2 and 2a, respectively of lines 3 and 3a the square cans with rounded corners and the square cans with flattened corners will fail and will implode. In the case of the circular-cylindrical can the autoclave pressure is fully responsible for a high difference between the inside can pressure and the autoclave pressure. The pressure difference Δp is fully borne by the can wall. Contrary thereto the relation is strongly non-linear for filled non-circular cans. As a result of the volume change in the can, the autoclave pressure is partly borne by the stiffness of the can body and partly borne by a pressure increase in the headspace. It can be concluded that the mentioned can with flattened corners resists a higher autoclave pressure than existing circular and non-circular

cans. This enables the use of much thinner material for the can body.

Fig. 7 represents along the vertical axis the maximal autoclave pressure in bars that can be borne by the filled can for different headspaces indicated in %. It appears that for practical headspaces between 2 and 15 % the can with flattened corners resists extremely high autoclave pressures. It can be concluded that implosion of the mentioned can with flattened corners is very unlikely (line 3).

CLAIMS

1. Metal body for packaging purposes comprising a closed metal shell extending around a longitudinal axis which is suitable for being provided on a side named here as the top with a lid running essentially perpendicular to the longitudinal axis, characterised in that the cross-section through the shell on and close to the top has a contour comprising $3 \leq n \leq 6$ curved concavely inwards with a minimum radius of curvature R, and n essentially straight contour line pieces, as well as in that the shell comprises at least n essentially flat shell parts, which are separated from one another by a sharp fold running essentially parallel to the longitudinal axis, which fold has a maximum radius of curvature r, whereby $r \leq 0.4$ R.

2. Body in accordance with Claim 1, whereby $R \geq 15$ mm.

3. Body in accordance with Claims 1 or 2, whereby $r \leq 5$ mm.

4. Body in accordance with one of the preceding Claims, characterised in that the flat shell parts run essentially parallel to the straight contour line pieces.

5. Body in accordance with one of the preceding Claims,

characterised in that it comprises at least 2n essentially flat shell parts.

6. Body in accordance with one of the preceding Claims, characterised in that it comprises at least 2n sharp folds.

7. Method for heat treating, for example sterilising a filled can comprising a body in accordance with one of the Claims 1-6, whereby a pressure p_{amb} is exerted on the can and a pressure p_{can} prevails in the can, whereby $\Delta p = p_{can} - p_{amb}$, and $p_1 < \Delta p < p_2$, characterised in that $p_1 <<< p_{1\ ref..}$ and $p_2 \leq p_{2\ ref..}$, where $p_{1\ ref..}$ and $p_{2\ ref..}$ represent respectively the minimum and maximum Δp for a conventional reference can.

8. Gas-tight can filled with non carbonated drink or food, such as vegetables, fruit, pet food, fish, meat or soup, comprising a metal body in accordance with one of the Claims 1-6.

9. Can in accordance with Claim 8 of packaging steel, whereby the material thickness of the packaging steel from which the body is made is thinner than 0.16 mm.

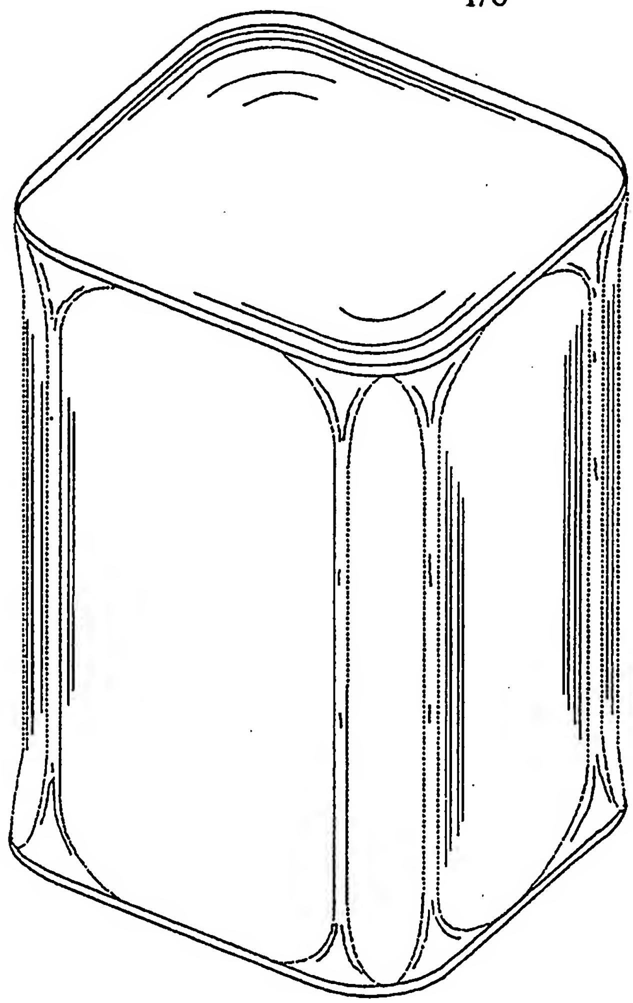

Fig. 1

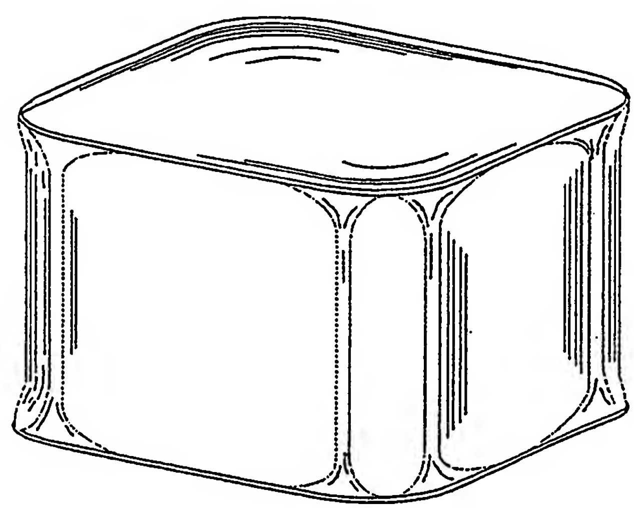

Fig. 2

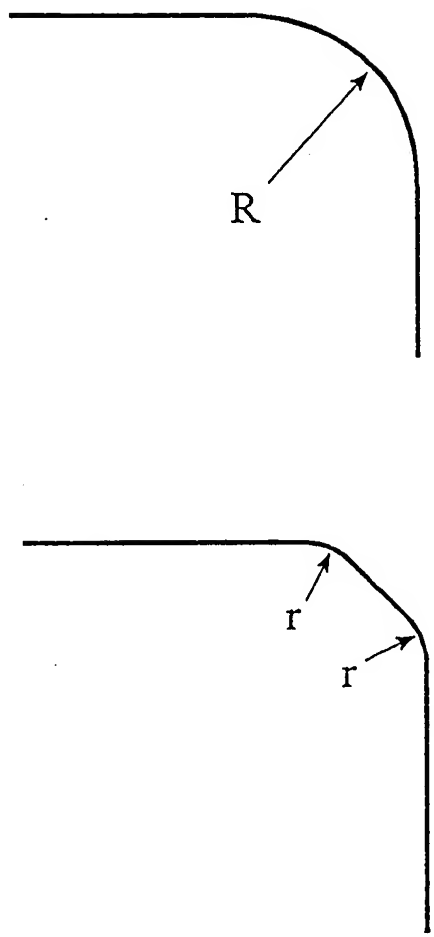

Fig. 3

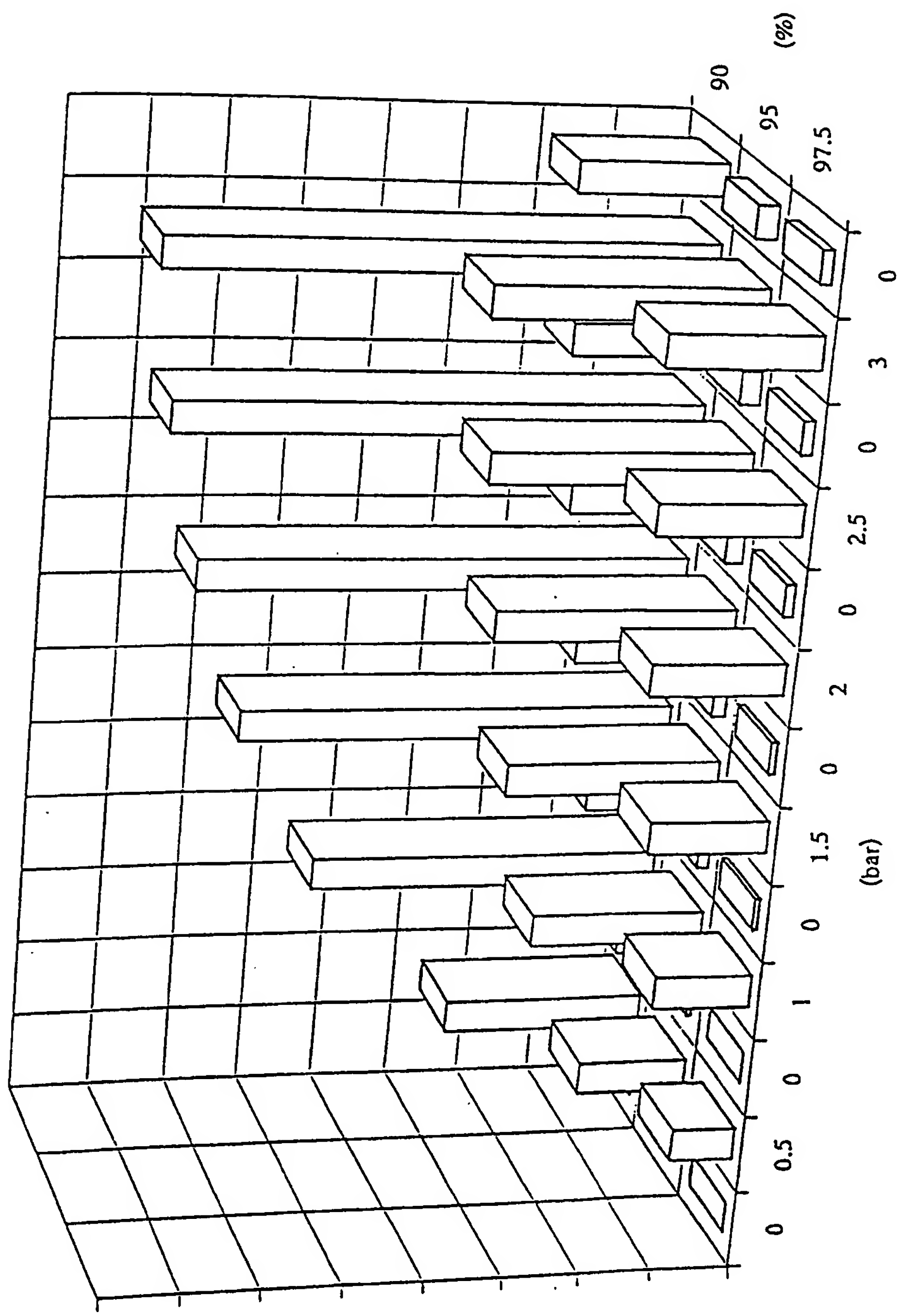

Fig. 4

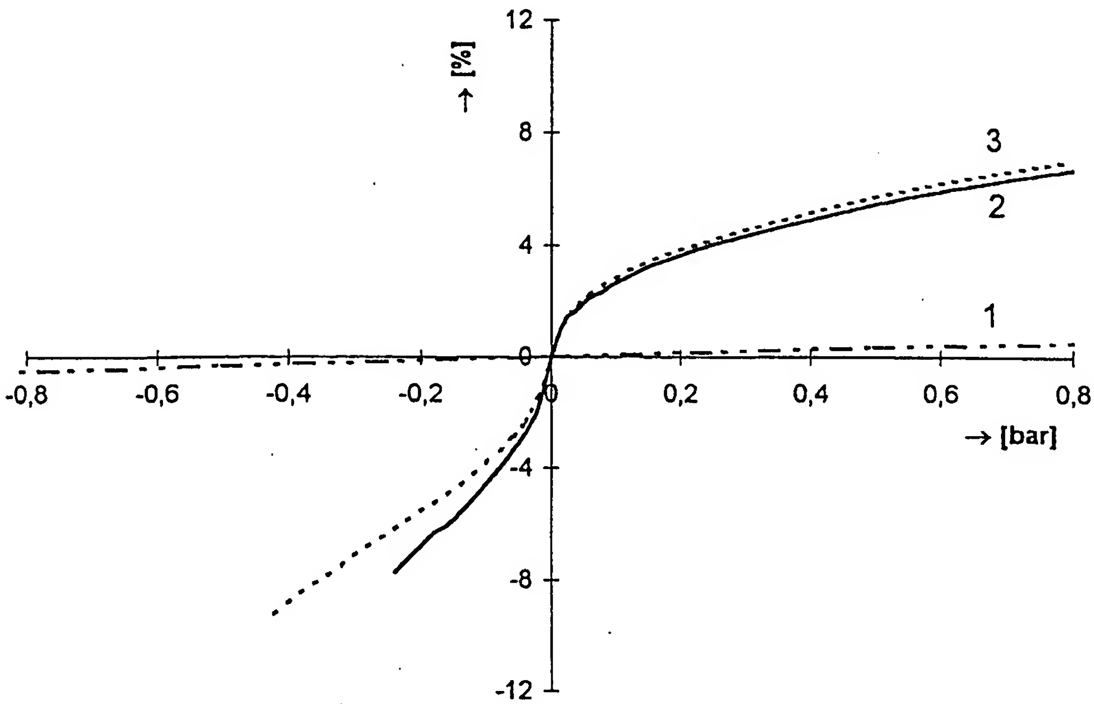

Fig. 5

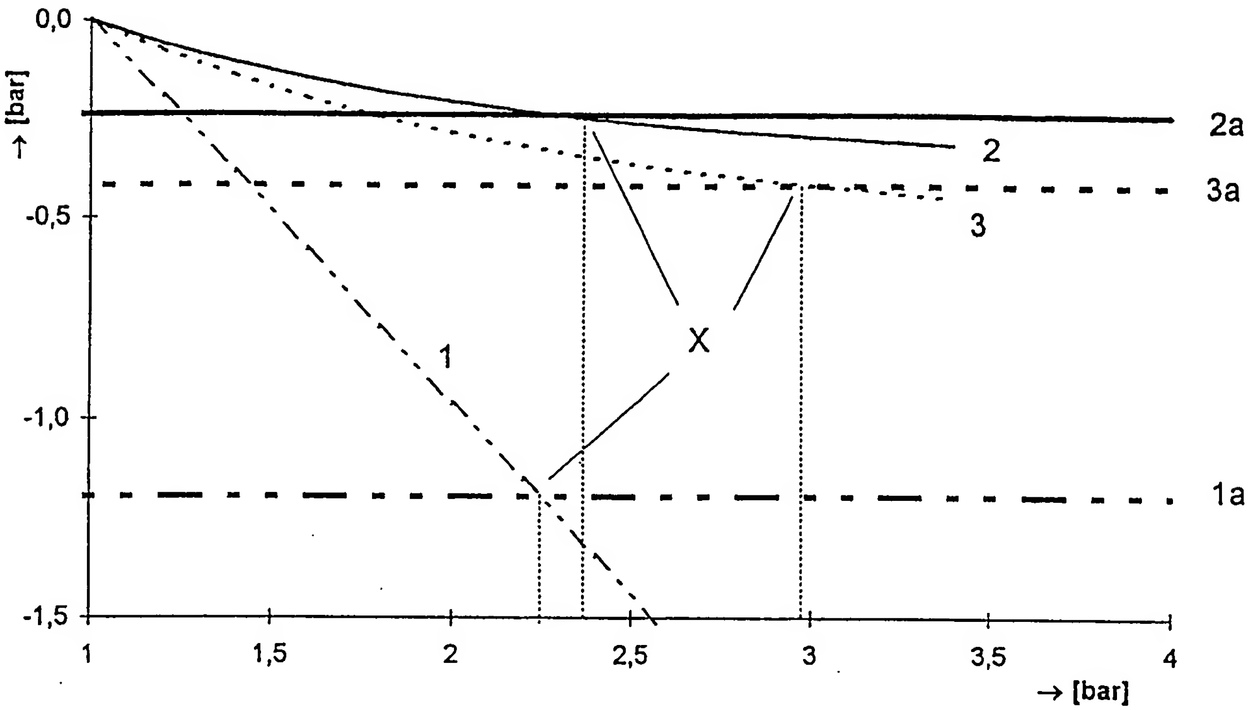

Fig. 6

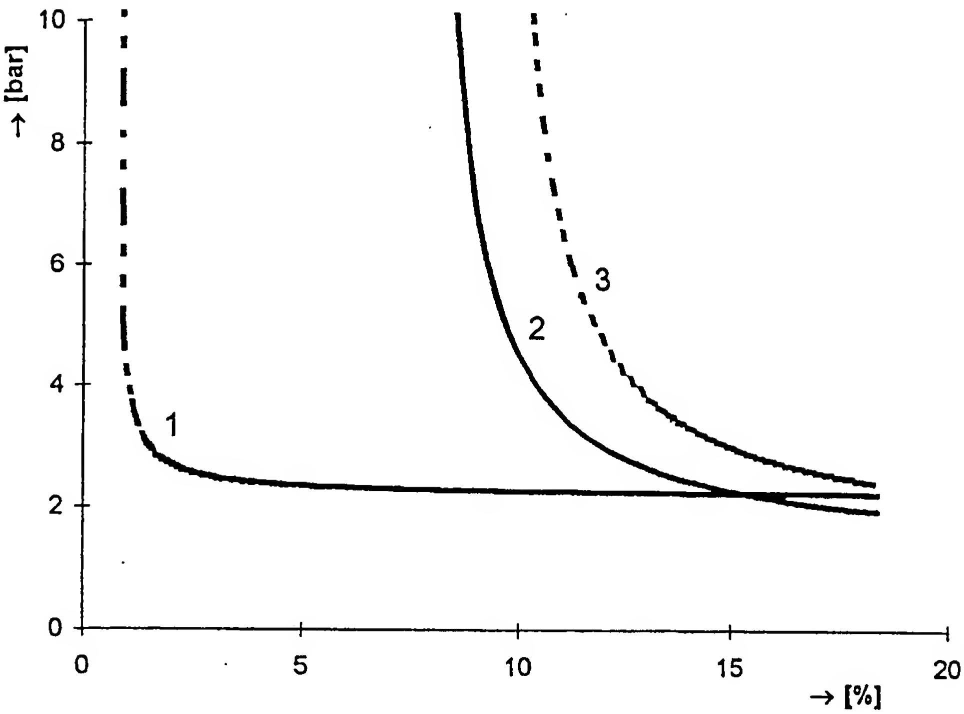

Fig. 7

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65D6/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65D B21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 563 408 A (BIJVOET) 16 February 1971 see column 1, line 74 - column 4, line 33; figures 1-4 ---	1-9
A	FR 1 325 082 A (GALLAY) 26 July 1963 see page 2, column 1, line 1 - column 2, line 9; figures 1-3 ---	1-9
A	EP 0 097 399 A (GLERUM) 4 January 1984 see page 3, line 10 - page 4, line 9; figures 1-5 ---	1-9
A	US 1 262 289 A (WEBER) 9 April 1918 see page 1, line 109 - page 2, line 85; figures 1-3 --- -/--	1-9

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[X] Patent family members are listed in annex.

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P[illegible]P 98/05128

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DE 21 65 139 A (ROPER) 20 July 1972 see page 6, line 3 - page 4, line 28; figures 1-3 -----	1-9

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